The STATE *of* TRANSPORTATION STATISTICS

Congress requires BTS to report annually on the state of the transportation system, documentation of the methods used to obtain and ensure the quality of the statistics presented in the report, and recommendations for improving transportation statistical information.[1] This chapter presents the state of statistics needed to answer the fundamental questions: are transportation and the world it affects getting better or worse, and what do we mean by better or worse?

Effective answers to the fundamental questions depend on both raw data and analytical tools to turn that data into effective information. BTS is pursuing parallel strategies to improve our understanding of the somewhat distinct worlds of freight and passenger transportation. The Bureau integrates these worlds through its emphases on the geography, finance, and performance of transportation.

Freight Transportation Activity and Services

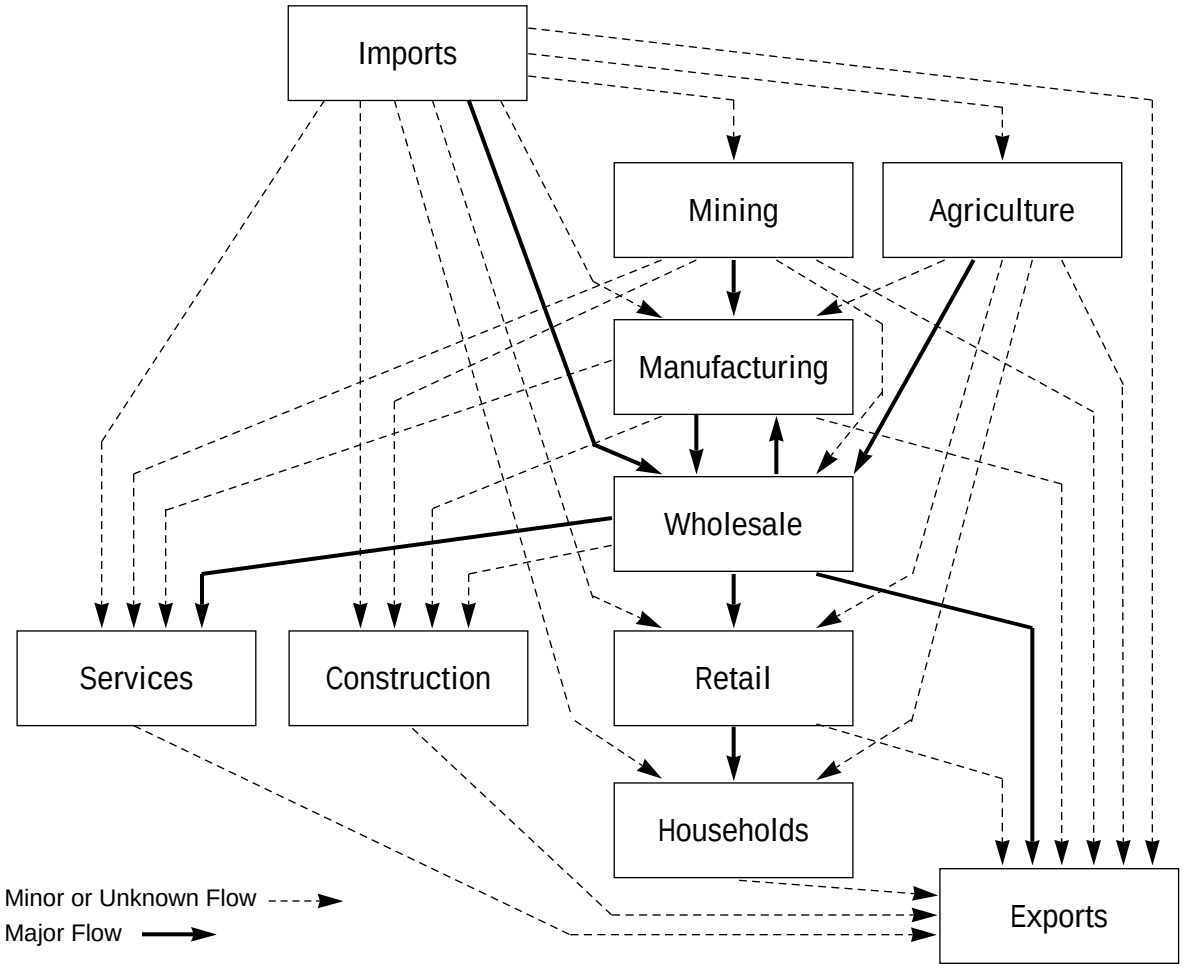
Any comprehensive effort to monitor commodity movements and multimdal freight transportation activity throughout the United States is an enormous undertaking. The shippers, arrangers, carriers, recipients, and disposers of shipments include nearly six million business establishments and over 90 million households. There are also more than 83 thousand governmental units that can ship, transport, or receive goods.

The complexity of the freight transportation universe is illustrated in Figure 4–1. Each of the flows in the figure can be subdivided as shown in Figure 4–2. The shipper may handle the shipment in the shipper's own vehicles, or turn the shipment over to a for-hire carrier or a transportation broker, freight forwarder, or other "third party." Third parties and many long-distance carriers work with other for-hire carriers to get the shipment to its final destination. The frequent result is that no one party knows all of the players and modes that were involved in moving the shipment from the shipper to its ultimate destination. Except for hazardous cargo, there are no standard documents that accompany or track shipments across all modes of transportation.

The size of the nation's transportation system and the variety of establishments and individuals involved in transporting

FIGURE 4–1

Commodity Flows Through the Economy



goods precludes the use of a single method, model, or survey to capture the universe of freight transportation activity. This universe must be viewed from a variety of vantage points: measuring the shipments, carriers, shippers, and the vehicles that comprise freight transportation activity.

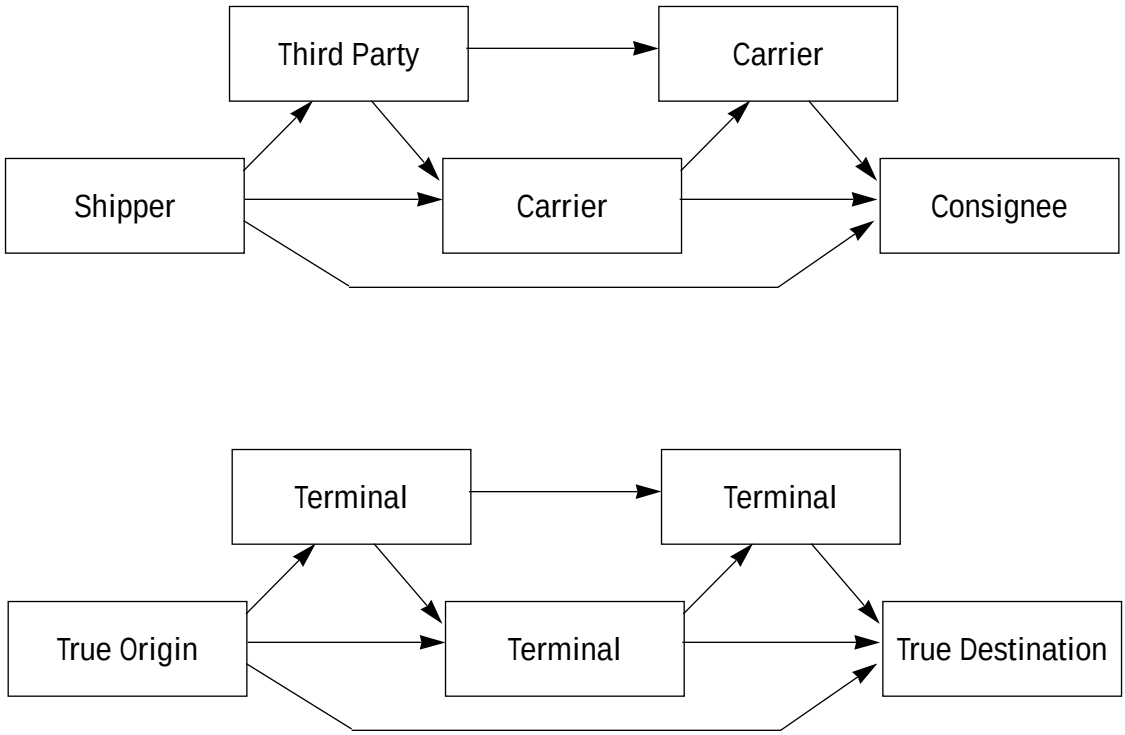
Shipment Data

Shipment data includes basic information on what commodities move, where they move, and how they get there. These data can be collected from the carrier, arranger, or shipper. As suggested by Figures 4–1 and 4–2, carriers know much about the shipment's specific route and handling while it is in their care, but that is often only part of the trip. The carrier is also unlikely to know much about the economic activity of many shippers and consignees. Carriers may not even know what they are moving if the commodities are containerized and moving under a general rather than commodity-specific rate, both of which are increasingly common. In contrast, the shipper usually knows the shipment's characteristics, ultimate origin, and ultimate destination, as well as the characteristics of both shipper and consignee. The shipper knows little, however, about the modes and routes used by the carriers, especially when the shipper's volume or individual shipment size are small and when multimodal parcel delivery services or third parties are involved.

Most ongoing data on commodity movements are collected from carriers.

FIGURE 4–2

Components of a Commodity Flow Between Two Sectors of the Economy



The Interstate Commerce Commission, the Federal Energy Regulatory Commission, and the U.S. Army Corps of Engineers obtain shipment records from railroads, pipeline operators, and inland waterway operators respectively. These records include the size of shipments by origin and destination. These data generally do not indicate the true origin and destination for shipments that are handled by more than one carrier or mode, and commodity movements by truck are completely absent.

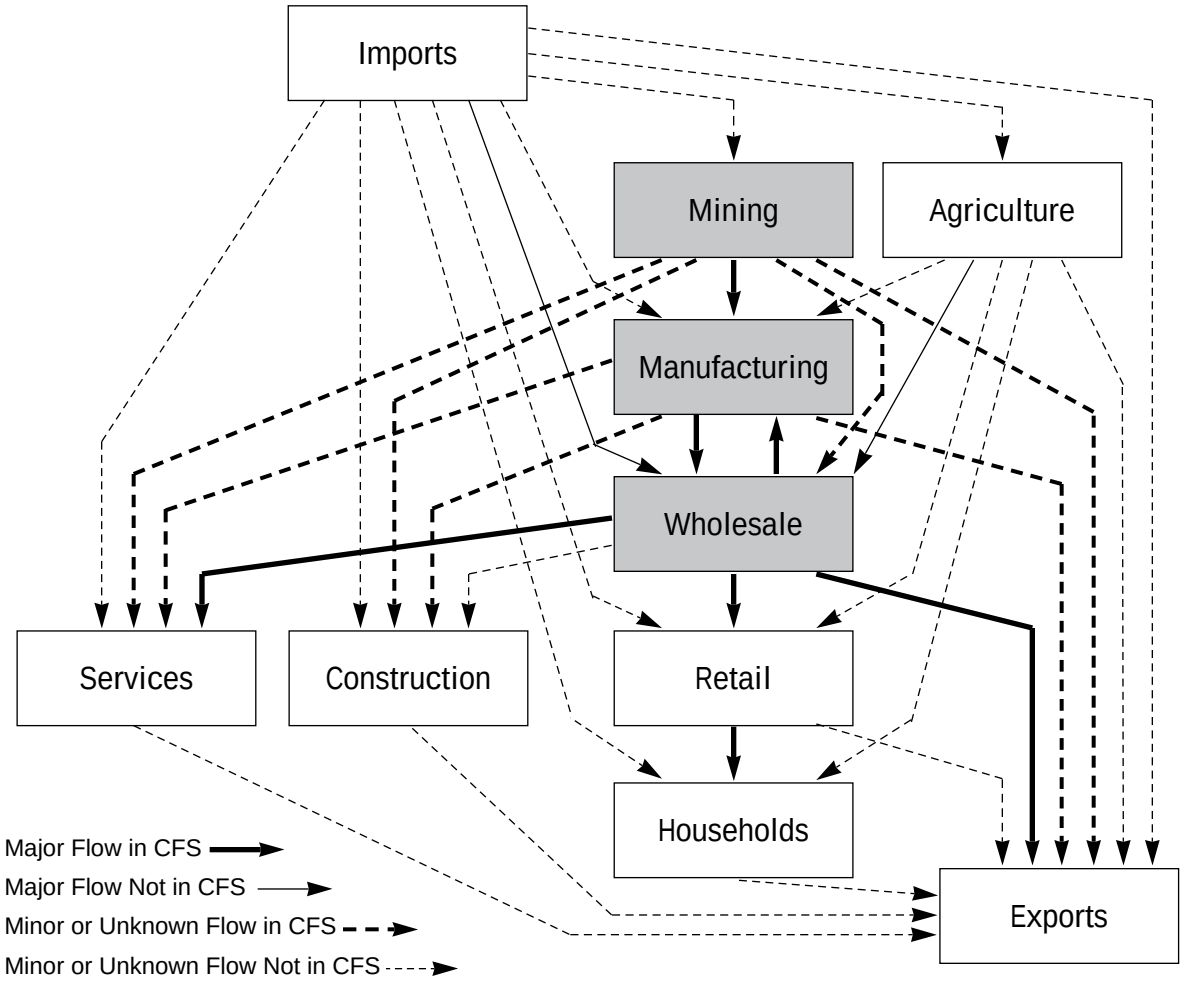
The Commodity Flow Survey. Until recently, the only shipment data for commodity movements by all modes of transportation were from the Commodity Transportation Survey. This quinquennial survey was conducted by the U.S. Bureau of the Census between 1963 and 1977, and was limited to shipments by domestic manufacturers. The 1977 survey encountered technical problems that could not be resolved with the limited funds for data collection in the 1980s.

These data are finally being updated and significantly expanded by the Commodity Flow Survey (CFS), which was conducted by the Census Bureau throughout calendar year 1993 as a regular part of its quinquennial economic censuses. The Department of Transportation funded those portions of the CFS dealing with the commodity and geographic detail. CFS data products will be available for distribution starting in the second half of 1995.

CFS coverage is indicated by the filled boxes and heavy outlines in Figure 4-3. Approximately 12 million shipments were sampled from 200,000 establishments selected from the 800,000 establishments in manufacturing, mining, wholesaling, warehousing auxiliaries of multi-establishment companies, and selected other industries. This large sample is needed to support statistically reliable tabulations of tons, ton-miles, and value by commodity type, mode of transportation (including intermodal combinations), shipment dis-

FIGURE 4–3

Universe of the Commodity Flow Survey



tance, shipment size, and combinations of origins and destinations.

The largest anticipated missing pieces of freight transportation activity include:

- Shipments from over three million farms to agricultural assemblers, virtually all of which are by truck, and much of which moves over relatively short distances;
- Imports from the port of entry to the manufacturer's or wholesaler's facility;
- Landbridge movements, in which shipments from foreign origins cross the United States and depart for foreign destinations;
- Shipments by governments, such as municipal garbage and transfers of munitions among military bases;
- Waste shipments by manufacturers, some of which are hazardous; and
- Household goods movements.

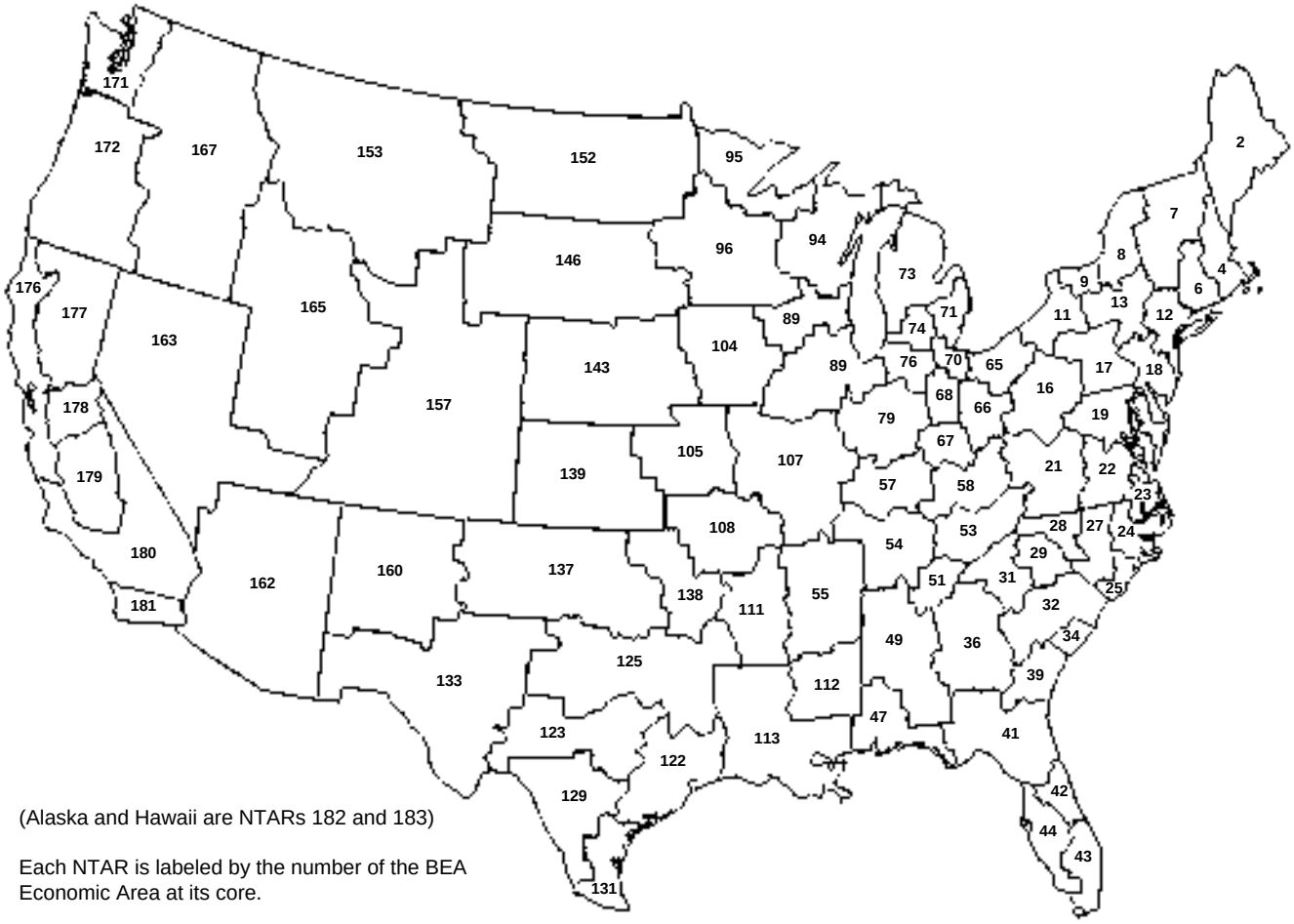
Methods for estimating the magnitude and geography of these missing pieces are being investigated.

Origins and destinations are summarized in the CFS by State and National Transportation Analysis Region. As shown in Figure 4–4, NTARs are aggregations of Bureau of Economic Analysis's Economic Areas and reflect the functional geography of markets and economic spheres of influence.

International Shipment Data. Shipment data on imports and exports are collected by the Customs Service and processed by the Bureau of the Census into foreign trade statistics. These trade data have traditionally suffered from several major problems, including the lack of

FIGURE 4–4

National Transportation Analysis Regions (NTARs)



(Alaska and Hawaii are NTARs 182 and 183)

Each NTAR is labeled by the number of the BEA Economic Area at its core.

reliable information on the domestic leg of the international movement. (See Needs for Data box.)

The Bureau of the Census is continuing its efforts to improve its identification of domestic inland origins and destinations of foreign trade, and BTS is working with Census to better identify the mode of transport used at international crossings. The Census Bureau began in April 1993, to distinguish surface modes (truck, rail, and pipeline) used for transborder shipments between the U.S. and Canada and the U.S. and Mexico under an interagency agreement with the BTS.

Information on the mode of transport used for the inland movement of foreign trade was last collected in 1975 by a DOT-funded Census program. The mode of transport used for the inland movement of exports has been captured by the CFS, although the ability to publish quality data is presently unknown since the CFS is not designed specifically to measure export shipments. Additional data collections are needed to capture the domestic movements of imports and landbridge traffic, as well as corroborate the export data from the CFS. BTS proposes to resurrect and expand the 1975 survey in which the Census Bureau drew a sample of export and import declarations and asked the filing establishment for information on the domestic leg of the shipment. A new survey would also be designed to collect data from carriers on through-shipments such as the landbridge traffic. In all cases, BTS would ask for the type, value, weight,

Needs of the Transportation Community for Foreign Trade and Tourism Data

Transportation facilities, services, and the flows of people and goods do not stop at the international border. The ports of Montreal and Halifax vie with New York to link Europe with markets in the Midwest and Ontario. U.S. airlines compete with foreign flag carriers for passengers at home and abroad. Asian products that formerly reached the eastern U.S. via the Panama Canal now pass through West Coast ports and travel by rail across the continent. Miami is a major hub for passenger flows between Europe and South America, and a point of departure for the nascent cruise ship industry. Growing trade between Canada and Mexico is blazing new north-south corridors through the U.S.

Transportation statistics—like transportation activity—should not be constrained by the border. Informed decisionmaking requires an understanding of how international activity places demands on the domestic transportation system, and how the domestic transportation helps bring foreign business and tourism to the U.S.

The advantage of transborder transportation activity is that movements of people, goods, vessels, and craft are recorded for purposes of tariff collection, immigration control, countermeasures against smuggling, and the calculation of trade balances. The problem is that data collected for these purposes overlap—but do not match—the needs of the transportation community:

- The trade community is concerned with goods and people who enter and exit the U.S. economy, which is not necessarily the same as U.S. territory. For example, "landbridge" traffic between Canada and Mexico does not enter the economy, even though it consumes hundreds of miles of U.S. highways and railroads. Customs is interested only in making sure that everything that entered subsequently left, while the transportation community is vitally interested in how and where the goods passed through the domestic transportation system.
- The trade community is primarily interested in the value and ownership of commodities traversing the border, while the transportation community is concerned with the weight and other physical attributes of the commodity that affect its transportability.
- The trade community is interested in who moved the goods for purposes of recordkeeping and enforcement, while the transportation community is more interested in how the goods are moved.

While the data interests of the trade and transportation communities do not correspond exactly, they are closely enough aligned to be served by one-stop reporting and extensive use of administrative records rather than interviews at the border.

Several efforts are underway to minimize barriers to movement across the border, to improve the effectiveness of contraband interdiction, and to provide an effective trade data base for economic development planners at all levels of government. These efforts can provide an effective data base for transportation planners as well, or they can undermine the utility of trade data for transportation if critical data elements are jettisoned.

For trade data to meet the needs of the transportation community, data elements involving both commodity and passenger flows should include:

- the true geographic origins and destinations of shipments and trips (and not just locations of intervening terminals);
- the frequency and distance of shipments and travel;
- the transportation services consumed and the conveyances and facilities used;
- the port of embarkation or arrival for international movements; and
- the transportation costs to the shipper or traveler, including accidents and damage.

Additional data elements involving commodity flows include:

- volume by commodity type and hazard class, measured by shipment weight and value;
- containerization and other packaging characteristics; and
- characteristics of the shipper and receiver that generate—or are affected by—commodity flows.

Additional data elements involving passenger flows include:

- the purposes and duration of the trip; and
- the demographic and economic characteristics of the traveler and the traveler's origins and destinations that generate—or are affected by—passenger flows.

These and other data elements are combined to forecast future passenger and commodity flows, determine how well the current transportation system serves current and future flows, and to evaluate the consequences of those flows for economic, social, and environmental goals.

While country of origin for imports and country of destination for exports is adequate for understanding intercontinental transportation, greater geographic specificity is needed for shipments to and from either Canada or Mexico to identify, understand, and forecast:

- competition between ports of the three nations for inland traffic;
- competition and complementary activity between parallel transportation services near the borders; and
- north-south corridors between Canada and Mexico.

The U.S. Department of Transportation must ultimately have the same detailed understanding of Canadian and Mexican traffic as U.S. domestic transportation since the systems of the three countries complement and compete with one another. Ultimately, the content and specificity of these data items are essential to estimate the impacts of domestic policies on the ability of the U.S. transportation system to serve the needs of North America and to connect the U.S. with the world.

domestic modes, and geography of each sampled shipment.

Carrier Data

Carrier data includes information on service availability and performance, which have a significant influence on the modes chosen to serve individual freight flows. Most railroad, waterway, pipeline, aviation, and intermodal facilities are listed in public reports or private guides. DOT monitors and publishes on-time performance by the airlines, and similar information is available from Amtrak. Guides to trucking are less comprehensive, largely because the industry is large, ubiquitous, and has a high turn-over rate.

Most carrier performance data are limited to economic performance. Revenue, expenditure, and related data are collected by regulatory agencies, trade associations, and financial rating services. Much of the financial data formerly collected by federal regulatory agencies are now being obtained by the Bureau of the Census, which is expanding its annual surveys and quinquennial Economic Census to include establishments primarily engaged in for-hire transportation or in services related to transportation.

The longest time-series provided by Census on carriers is the Annual Survey of Motor Freight Transportation and Public Warehousing, which covers companies that have payrolls and that are primarily engaged in for-hire trucking and warehousing.[2] This survey includes questions on employment, revenue, expenses, and truck fleet size. A smaller set of questions focusing on kinds of business activity and expenditures is used for the complete census of motor carriers in the quinquennial Economic Census.

As of 1992, the Economic Census provides revenue, payroll, and other limited economic data on establishments primarily engaged in for-hire trucking and warehousing, water transportation, nonscheduled air carriers, and transportation services. Similar data on scheduled airlines are reported to the BTS Office of Airline Information, and data on large railroads are reported to the Interstate Commerce Commission.[3] Data on short line railroads are not collected, leaving a significant gap in our understanding of local freight transportation service.

Neither the Economic Census nor related annual surveys provide data on private trucking and other transportation activity of establishments that are not primarily engaged in for-hire transportation. Limited data on all bus- and truck-operating establishments are collected by the Office of Motor Carriers of the Federal Highway Administration to monitor carrier fitness and safety.

Shipper Data

The Census Bureau collects data on revenues, expenditures, employment, resource consumption, and product output for establishments throughout the economy in its annual surveys and quinquennial Economic Census, Census of Agriculture, and Census of Governments. These data collection programs provide information on sources of demand for freight transportation, and provide the sample frames for surveys of shipments.

Roughly one-half of all commodity movements by truck and intermodal combinations including trucks are made in vehicles operated by manufacturing, agricultural, retail, and other establishments that are not for-hire motor carriers. Of the remaining share, a significant but unmeasured percentage of activity is served by independent owner-operators who do not have payrolls. To capture the relationships of commodity transportation to economic condition for the full range of this activity, the scope of existing surveys would have to be expanded to cover trucking auxiliaries, private trucking, and independent owner-operators who do not have payrolls. This expansion will be practical only if requisite screening questions are included in the other parts of the Economic Census (such as the Census of Manufacturing and the Census of Agriculture) to obtain a cost-effective sample frame.

Vehicle Data

The large percentage of commodity movements that are served by not-for-hire motor vehicles can be measured directly by surveys based on vehicle registrations or by roadside observations. This sam-

pling strategy has many of the strengths and weaknesses of data collections on shipments from carriers, but can be applied to both motor carriers and others that are not primarily in for-hire truck transportation.

Surveys based on motor vehicles can provide a powerful supplement to the CFS because highways carry the largest and least-known portion of trips and shipments. Vehicle registration files provide a sample frame that is generally not limited by the economic activity of establishments or the household status of individuals; the only limitation involves vehicles owned by governments.

The power of this sample frame is illustrated by the Truck Inventory and Use Survey (TIUS), which remains the only direct source of nationwide payload ton miles by type of truck. The TIUS has been conducted by the Bureau of the Census as part of the quinquennial Economic Census since the 1960s, and is based on a sample of registered trucks in each state. Extensive information is collected on the characteristics of each vehicle and its annual use, but lacks effective information on the location of truck travel.

States estimate aggregate vehicle activity by highway and vehicle class for FHWA based on roadside counts as part of the Highway Performance Monitoring System (HPMS). Counts by vehicle type on sampled sections of major highways provide useful "screen line" data to check the magnitude of commodity flows; however, the HPMS provides no information on the content of those flows.[4] The HPMS cannot link vehicle activity to commodities carried because it depends increasingly on automatic vehicle identification and weigh-in-motion equipment that measures the vehicle's exterior characteristics only. Together, though, the HPMS and TIUS can be used to link commodity movements and highway type through models described in the following section.

Beyond National Surveys

National surveys alone cannot provide a complete, integrated picture of freight transportation activity and services. Such surveys are precluded by cost and confidentiality issues from providing adequate information for local transportation planning. Even for understanding at the national scale, no single strategy can provide complete coverage of all modes, establishments engaged in freight transportation activity, and other players who affect—or are affected by—freight transportation activity. Models and special analyses are needed to integrate diverse data sources and obtain the needed national picture. Additional data collection is also needed at the local level, since no existing model of freight demand is adequate to estimate county-to-county or more localized freight transportation activity from national data sets. (See Role of Models box.)

At national or local levels, the volumes of goods shipped and people moved can be translated with modest assumptions into volumes of vehicle and carrier activity; however, the consequences of those volumes for economic productivity, energy consumption, and environmental problems cannot be calculated without additional information. The most contentious added data elements are the in-use fuel economy of motor vehicles and railroad equipment, and transportation costs to the shipper or traveler. The former is measured by rough estimates from survey respondents and by controlled tests under artificial conditions. The latter is measured by a shrinking number of regulatory reports, by aggregate cost data from carriers, by private and government surveys of limited ranges of establishments, and by anecdotal evidence.

Special studies are needed to develop better estimates of in-use fuel economy and to estimate transportation costs by mode, carrier type, and distance-based market. Data from simulations and laboratory tests are inadequate substitutes for field tests under normal conditions.

Finally, the freight transportation data community must begin to shift its focus from the national scale to the local scale. Efforts to identify and improve methods of local data collection are relatively recent, and should be encouraged. More than a decade has passed since the last major round of urban goods movement studies. The old methods and findings should be revisited in light of more recent issues such as intermodal planning requirements and international competition for local industries. The long tradition of urban

The Role of Models

Virtually all efforts to monitor transportation activity involve one or more models. Models of primary interest to BTS are used to expand samples to a universe, measure a characteristic at the intersection of data sets, and integrate separate data sets into a total picture. Models of primary interest to policy offices are used to forecast future conditions, particularly when the condition may be affected by a proposed policy or other action.

Samples of transportation activity are expanded into a universe by two basic approaches. *Statistical models* are commonly used to expand samples to a universe, particularly when the sample size is large or the geographical distribution of the activity being measured is relatively uniform. For example, individual shipments reported for the Commodity Flow Survey (CFS) are turned into estimates of interregional flows based on the output of the shipper, the way in which the shipper was sampled from all establishments in the shipper's industry, and the total output of that industry. Simple extrapolation or more sophisticated statistical models can then be used to estimate transportation activity in between years in which the survey is conducted. Network simulation models are more appropriate when the activity being measured is geographically diverse and sample sizes are too small to support statistical models. *Network simulation models* are based on the assumptions of how individual firms and households respond to local geography and to available transportation resources. Shipment distances in the CFS are estimated by simulating the routing decision of shippers given the costs of using available parts of the transportation network.

Models are often used to obtain information that cannot be measured directly. In some cases, the requisite information can be obtained by linking separate data bases-such as the results of different surveys of the same shippers-through common variables in a relational data base. Unfortunately, desired cross-tabulations in transportation are typically too complex for either a relational data base or for direct measurement. For example, informed policies on truck size and weight issues require estimates of ton miles by some combination of commodity type, industry of the shipper (manufacturing, wholesale, government, household, etc.), modes of transport, carrier type (for-hire company, owner-operator, business other than transport, personal), State, and multi-state corridor. We know from the CFS where commodities are carried by truck, and from the Truck Inventory and Use Survey what kinds of commodities are carried by what kind of truck. We need a very sophisticated network simulation model to combine the results of those surveys to integrate disparate data sources and provide cross-tabulations that cannot be estimated directly.

Unfortunately, the longest tradition of network simulation models in transportation is limited to local urban passenger travel. This tradition is based on the tendency of households to travel in geographic patterns that are relatively easy to summarize by a few key variables. The number of trips taken and distance traveled are functions of household size, income, and other attributes that apply to large segments of the population over long periods of time. In contrast, the transportation activity of business establishments varies radically by the type of commodity or service produced, by the market served, and by other factors which are industry-specific and not always correlated to easily measured attributes such as size of establishment. The transportation activity of a nearly ubiquitous service such as grocery stores may be as spatially and temporally stable as the travel behavior of households, but the quantity and direction of transportation activity for establishments such as construction companies will shift radically from project to project over a wide geographic area in the course of a year. Effective models of non-passenger transportation activity at the county-to-county level or greater geographic detail must be built on new approaches and significant local data collection.

transportation models has little to offer the freight side for the reasons given in the box on the role of models.

Passenger Transportation Activity and Services

Separate strategies are required for measuring freight and passenger transportation because boxes can't talk but usually leave a trail of shipping documents, while people can describe their travel but don't always have records to jog their memories. Freight activity is generated mostly by businesses and is primarily sensitive to economic conditions; passenger activity is dominated by households and affected primarily by demographic conditions. Data collection and model development have emphasized intercity transportation to the near exclusion of urban concerns on the freight side, while data and models have a strong urban tradition and a weaker intercity tradition on the passenger side.

The measurement of freight and passenger transportation also share many similarities. Recent data on intercity movements exist only for terminal-to-terminal flows by non-highway modes, and intermodal surveys for door-to-door intercity travel are just now underway after a 17 year hiatus. Current programs measure outbound transportation by shippers and travelers while missing the domestic transportation of foreign goods and non-residents. Business establishment data are limited to for-hire carriers, missing a large segment of transportation service (such as private trucking for freight and school buses for passengers). Models to integrate and forecast activity must be rethought in light of new societal conditions and planning requirements.

Within the topic of passenger transportation activity, data collection programs and problems divide readily among local travel, long distance domestic travel, and travel to other countries. (See Table 4–1). Passenger movements are measured mainly by household surveys, ticket collections, and roadside vehicle counts, but the specific approach varies between daily, repetitive local travel and less frequent and more geographically diverse long distance travel.

Local Travel

Existing knowledge of local passenger transportation activity is a trade-off between trip/traveler characteristics and geographic detail. One national survey provides details on all types of trips with virtually no geographic specificity, the decennial census provides great detail for only one trip purpose, and local data generally include geographic detail for all trip purposes without distinguishing among the purposes.

The importance of understanding both geography and trip purpose is suggested by Figures 4–5 and 4–6. Figure 4–5 shows significant variation in travel by trip purpose and time of day, while Figure 4–6 suggests significant geographical variation for just one of the trip types: the journey to work. Better understanding of the interaction of those characteristics is key to identifying the stress points on local transportation systems and the areas where environmentally driven travel reduction or modal diversion programs may collide with human desires.

TABLE 4–1

Principal Sources of Passenger Travel Data

	Local Travel of Local Residents	Local travel of Out-of-Town Visitors	Long Distance Domestic Travel	Travel Overseas
U.S. Residents	Nationwide Personal Transportation Survey	Local tourism studies in some locations	American Travel Survey, Airline and Amtrak tickets	American Travel Survey, U.S. Customs
Foreign Visitors	Not Applicable	Local tourism studies	U.S. Customs	U.S. Customs (in transit)

FIGURE 4–5

Person-Trips by Purpose by Time of Day: 1990

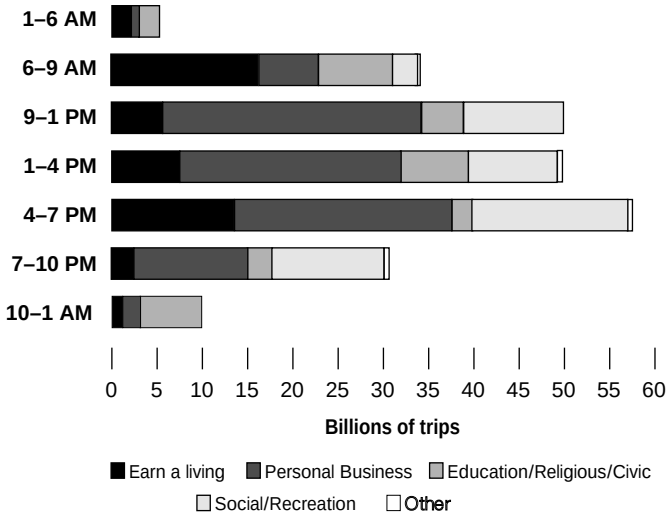
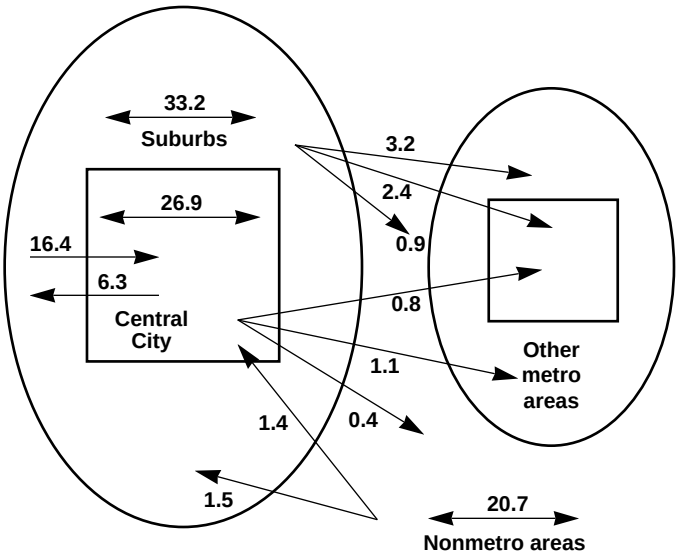


FIGURE 4–6

National Commuting Flow Patterns
(Millions of Daily Trips)



The Nationwide Personal Transportation Survey

Figure 4–5 is based on the Nationwide Personal Transportation Survey, which is conducted approximately every 5 years by DOT. The NPTS provides a wealth of information on the trip purposes, modes and vehicles used, demographics of the traveler, and other characteristics of travel. While the NPTS includes all travel, its small sample size (25,000 households) and limited recall period (one telephone interview covering a sample day) are not designed for capturing infrequent, nonrepetitive, long distance trips. The NPTS is most effective in measuring typical local travel.

The Decennial Census

Figure 4–6 is based on the workhorse of urban transportation data, the decennial census. The decennial census is the only national source of data on commuting patterns by small areas, and is an essential component of the urban transportation planning process.

The potential crisis with the Year 2000 Census, described by BTS in its *Transportation Statistics Annual Report: 1994*, has not yet been averted. Congress continues to question the need for and cost of the data, including the transportation data, that have historically been collected in the census for use in implementing federal programs. Options currently being discussed by the House appropriations subcommittee that controls the Census Bureau's budget include (1) limiting the number of questions in the census that collect data for federal programs, (2) requiring federal agencies to reimburse the Census Bureau for the cost of collecting and processing the data, or (3) dropping from the census altogether the questions that collect data needed for federal programs and forcing agencies to find or develop alternative sources for the information. The Census Bureau continues to promote the collection of data in smaller monthly surveys conducted throughout the decade in a "continuous measurement" system.

At the same time Congress is looking at ways to reduce the information collected in the census, the DOT and state and metropolitan transportation planning organizations are increasingly reliant on the nationally consistent, cost-effective data collected in the decennial census to implement the requirements of ISTEA and the Clean Air Act Amendments of 1990. In its role of coordinating the collection of transportation data with information-gathering activities of other federal departments, the BTS is continuing to work closely with the Bureau of the Census, the

Office of Management and Budget (OMB), and other federal agencies to represent the interests of the transportation community in decisions about the types of data that will be collected in the 2000 census and the method in which the census will be conducted.

The Prospect for Continued Collection of Transportation Data in the 2000 Census

After the 1990 census, the Census Bureau received a great deal of criticism from members of Congress who felt the census was too costly and inaccurate. The Congress expressed through the budget process its view that questions included in the census to collect data to meet federal program needs contributed significantly to the increase in the cost of the census and to the undercount of the population. In its report on the Census Bureau's fiscal year 1994 budget request, the House appropriations subcommittee directed OMB to ensure that only data required by law would be collected in the census at taxpayer expense.

Many federal agencies, including the DOT, expressed strong objections to restricting the data collected in the census (most federal programmatic data collected in the census are not specifically required by law). In response to these objections, Congress eased its position in subsequent budget guidance and directed the Commerce Department and OMB to ensure that the absolute data requirements of federal departments and agencies and state and local government data needs were considered in the 2000 census planning effort. But the guidance also included the stipulation that Congress expected other federal departments and agencies with significant data requirements, for which the decennial census is determined to be the most effective means of collection, would reimburse the Census Bureau for a portion of the costs of planning for and conducting the Year 2000 Census.

OMB requested federal agencies to formally submit their requirements for data from the 2000 census. In response to OMB's request, BTS provided on behalf of the DOT documentation describing the transportation data needed, the uses of the data for federal, state, and local transportation planning, and the legislation that requires the planning activities which depend so heavily on the decennial census data. Following the Congressional guidance that it ensure that only the absolute data requirements of federal agencies be considered in planning for the 2000 census, the OMB grouped all federal requests for decennial census data into three categories: (1) Decennial census data specifically *mandated* by legislation; (2) Data specifically required by legislation, for which the census is the only or historical source; and (3) Data used for *program* planning, implementation, or evaluation or to provide legal evidence.

Questions that collect decennial census data specifically mandated by legislation stand the best chance of being included in the 2000 census. Other questions that collect data specifically required by legislation would be second priority, while questions that collect data to fulfill program needs would be the lowest priority. The transportation data collected in the census are required by legislation, but the decennial census is not mandated as the source of the information.

The final decision of the Congress on the issue of 2000 census content remains to be seen. However, continued Congressional questioning of the legitimacy of data needs, perception of the adverse impact of the length and complexity of the census questionnaire on the undercount, and interest in reducing the cost of the census offer the very real possibility that the amount of information collected in the 2000 census may be reduced significantly compared with past censuses. If a "reduced-content" census becomes a reality, the transportation questions will survive in the Decennial census to the degree that their inclusion is made mandatory by law.

The Prospect for a Cost-Reimbursable Census

The conference report on the Census Bureau's fiscal year 1994 budget stated that the conferees expected that other federal agencies with significant data requirements, for which the decennial census is determined to be the most effective means of collection, would reimburse the Census Bureau for a portion of the costs of planning for and conducting the Year 2000 Census.

The Federal Agency Policy Committee for the 2000 Census assessed the feasibili-

The Continuous Measurement Alternative to the Decennial Census

The Bureau of the Census is continuing to promote "continuous measurement" as an alternative to the traditional census. Under a continuous measurement system, the decennial census conducted in 2000 would collect only population and housing unit counts and minimal demographic information such as age, race and Hispanic origin, sex, and household relationship. The transportation characteristics traditionally obtained from a sample of households using the long-form questionnaire, as well as the whole range of social, economic, and housing data collected on the long form, would not be collected. Instead, the long form would be replaced with a monthly Intercensal Long-Form Survey. Data from these continuous monthly surveys would be cumulated to produce averages over various periods of time. Annual estimates for large cities, metropolitan areas, and states could be derived by cumulating 12 months of interviews, but a five-year cumulative average would be required to produce estimates for small areas such as traffic analysis zones that are based on a sample of comparable size to that obtained in the traditional decennial census.

Data users within and outside the transportation community have been unwilling to embrace the continuous measurement system without a comparison between data collected by the proposed system and by the traditional long form. In April, 1994, the Transportation Research Board conducted the third National Conference on Decennial Census Data for Transportation Planning. DOT officials, Census Bureau representatives, and state and local transportation planners met in Irvine, California to review their experiences with using the 1990 census data for transportation planning and to make recommendations for the 2000 census. Census Bureau representatives described their proposal for a continuous measurement alternative to the traditional census.

The conference attendees recommended that a conventional census with appropriate improvements be implemented in the year 2000, along with a parallel test of the continuous measurement process. Then, if the resulting data from a continuous measurement system prove to be valid for transportation uses when compared with data from a conventional census conducted at the same time, a national continuous measurement system could be put in place by 2005.

To address the implications of data from a continuous measurement system for the uses of conventional census data in transportation planning, BTS conducted a formal study during the fall of 1994. A panel of experts representing the broad range of data users was briefed by Census Bureau staff and other statisticians who discussed the methodology, the pros, and the cons of continuous measurement compared with a traditional census.

Afterwards, the panel members carefully assessed the implications of continuous measurement within their particular area of expertise (travel forecasting models, clean air models, land use, transit planning, planning for large and small metropolitan areas, and so forth).

Like the attendees at the National Conference on Decennial Census Data for Transportation Planning, the study panel concluded that only after a parallel test of continuous measurement and a conventional census could continuous measurement data be evaluated sufficiently to determine their utility for the various applications of census data in the transportation planning process.

In the Decennial Census Improvement Act of 1991, Congress mandated that a study of the fundamental requirements for the nation's decennial census be undertaken by the National Academy of Sciences. As specified by the legislation, the Panel on Census Requirements in the Year 2000 and Beyond, under the Committee on National Statistics, was established to study (1) the means by which the government could achieve the most accurate population count possible, and (2) ways for the government to collect other demographic and housing data.

The Panel on Census Requirements conducted a comprehensive evaluation of the pros and cons of different ways of conducting the census, including continuous measurement. In its final report, *Modernizing the U.S. Census*, released in December, 1994, the panel concludes that it will not be possible for the Census Bureau to complete the needed research on continuous measurement in time to make the critical decisions regarding the 2000 census. Therefore, the panel recommends against substituting continuous measurement for the long form questionnaire in the 2000 census.

BTS supports the recommendation of the Panel on Census Requirements, The National Conference on Decennial Census Data for Transportation Planning, and the results of its own formal study: continuous measurement should not be substituted for the long-form questionnaire for the 2000 census. BTS encourages the Bureau of the Census to design and implement a test of continuous measurement to parallel the conventional 2000 census, so that data derived from the two methodologies can be compared and analyzed. If this test demonstrates that transportation data obtained from a continuous measurement system are adequately comparable to the data collected in the conventional census, implementation of a continuous measurement system should be considered prior to the 2010 census.

ty, risks, and benefits of sharing the costs of the census and concluded that there is no practical or feasible way of implementing this concept for the 2000 census. The Policy Committee, including BTS as DOT's representative, reached this conclusion for the following reasons:

1. Diffused funding sources for the census will not be cost effective because of uncertainties about the total cost to be shared and overhead costs to be incurred by each agency for handling the funds. Census costs would actually be higher as a result of each agency having to add overhead costs to census budget allocations.
2. Developing an agreeable cost-sharing formula would be difficult, and without firm obligations to contribute, a given agency's share may increase dramatically if other agencies are unable or unwilling to pay their allocated share.
3. The census is perceived as a national resource to which all citizens can have access. As a "public good" it is difficult to assess the value of the census data and how to charge persons for obtaining the data.
4. Cost sharing would spread responsibility among the agencies and their appropriations committees that place data requirements on the census. Diffused control and accountability may adversely affect the efficient conduct of the 2000 census.

The BTS supports the conclusion of the Policy Committee that it is neither practical nor feasible to implement a cost-sharing concept for the 2000 census. The decennial census is a national resource that benefits both the federal and non-federal sectors. Census data exist, in large part, because of federal legislation which directly or indirectly requires census data to meet the objectives intended by the law. The nation's interest will be served best by centralized funding of decennial planning and implementation costs in the Census Bureau for the 2000 census.

The Prospect for Transportation Data to No Longer Be Collected in the Census

A Congressional decision to exclude from the 2000 census data needed for federal programs is a very real possibility. If transportation data for states and metropolitan areas are no longer collected in the decennial census, a replacement program of state and local travel surveys must be designed and implemented to provide the data needed for transportation planning. BTS has been directed by the Deputy Secretary to take the lead within the DOT in developing a Decennial Census Transportation Data Replacement Program. In response to the Deputy Secretary's directive, BTS will begin the initial planning for this program in fiscal year 1996.

The Transit Question

While both the NPTS and the decennial census cover local transit use, neither are completely effective instruments for capturing the share and characteristics of transit use. The other major source of transit data—the Federal Transit Administration's Section 15 program—provides only total ridership and passenger-mile statistics by property.

The Travel Model Improvement Program

The bulk of data on local passenger transportation activity comes from home interview surveys, on-board transit surveys, and automatic vehicle counters by metropolitan planning organizations and other local agencies. Little has been done since the 1970s to advance the state of the art in data collection and analysis for urban travel, particularly in the area of origin-destination surveys.

One response has been the development of the Travel Model Improvement program (TMIP), a joint effort of FHWA, FTA, the Office of the Secretary of Transportation, and BTS, with financial support from the Department of Energy and the Environmental Protection Agency. TMIP was initially organized into four tracks, each of which reflects a current area of weakness in the state of local transportation data and analysis:

A. Outreach to bring practitioners throughout the states and metropolitan planning organizations up to speed in the current state-of-the-art in travel demand modeling and data collection.
B. Near-term improvements to make existing travel demand models more responsive to transportation management options, land-use concerns, and air quality issues.
C. Long term improvements to develop fundamentally new approaches that make existing travel demand models more responsive to transportation management options, land-use concerns, and air quality issues.
D. Data collection initiatives to provide inputs to existing and new models, to develop indicators of general conditions, and to capitalize on new technologies of data acquisition such as automatic vehicle identification and satellite-based tracking systems.

Initial proposals for the data track emphasize the need for better information on: the relations between travel behavior and vehicle ownership; driver characteristics that affect emissions; impacts of non-investment policy options such as pricing on travel demand; and the relationships of travel demand to demographic and urban development trends. Initial proposals also recognize the importance of understanding the impacts of commercial traffic on commuting and other personal travel, as well as the impacts of congestion on commercial traffic.

Long Distance Travel

Currently, the principal sources of data on long distance passenger travel are limited to terminal-to-terminal passenger flows for scheduled airlines and Amtrak. These data are based on a published 10-percent sample of airline tickets and a complete but not publicly accessible census of Amtrak tickets. These flow data do not include trips by private vehicles, intercity bus, or general aviation, and provide little information on the traveler, purpose of the trip, and segments of the trip between the airport or train station and the actual trip origin and destination.

The American Travel Survey. Our understanding of long distance passenger flows will increase dramatically with the Bureau's American Travel Survey. The ATS is the first nationwide, multimodal survey of passenger movements since the last National Travel Survey was conducted by the Bureau of the Census in 1977. The sample size of the ATS is four times greater than its predecessor, and will include numerous other improvements. The ATS is being conducted for BTS by the Bureau of the Census as a part of the quinquennial economic censuses.

Members of over 80,000 households are surveyed once each quarter throughout calendar year 1995. The sample is large so that statistically reliable estimates of passenger flows among states and among major metropolitan areas can be made. Sampled households received a packet of materials, including a map and a calendar with which they track their trips over 75 miles from home, and an introductory phone call before the four interviews are conducted. Households that do not answer or that do not have telephones are visited by an interviewer. Special interviews are conducted to test for potential biases in the responses and assure high quality statistics.

Information is being collected on the trip destinations, intermediate stops, modes of transportation used, trip purpose, size of travel party, trip duration, and types of accommodations used. Basic information on the demographic and economic characteristics of the household is also being collected. Trip distances will be calculated by Oak Ridge National Laboratory based on the origin, destination, and most likely path though the computer representation of the transportation network.

ATS will provide essential data for both the transportation community and the tourism industry. The results will provide the only national estimates of passenger travel by all modes of transportation and origin-destination patterns of personal vehicle travel. Results will be published in 1996.

Other surveys. There are other useful but limited sources of long distance passenger travel information developed in both the private and public sectors. These surveys cannot substitute for a comprehensive ATS; in fact, often they are depen-

dent on a comprehensive national survey to provide the measure of the total universe of passenger travel on which to base their more limited survey approaches.

The private sector's National Travel Survey is produced annually by the U.S. Travel Data Center of the Tourism Industry Association. This survey provides a very effective tool for monitoring trends in overall travel patterns, but its small sample size does not permit significant geographic identification. Historically, the industry has strongly supported the concept of a national passenger flow survey as a benchmark and guide to the industry's continuing survey activity.

Another source of information on long distance passenger travel is the Consumer Expenditure Survey of the U.S. Bureau of Labor Statistics. This survey is a very rich source of data on expenditures and activity related to travel paid by households. Business travel, about 15 percent of intercity passenger travel activity and a larger share of travel spending, is not within the survey's scope. This exclusion seriously limits the utility of the data for transportation applications, but the data can provide a useful adjunct to any DOT survey design.

International Activity

The international travel sector has always been an area of substantial statistical importance out of proportion to its share of travel activity, in large part because of its effect on the national balance of payments, but also because international relations, prestige, and competitiveness enter into the subject as well. From a transportation perspective, foreign travel is an increasingly significant segment of all travel. International travel has shown annual levels of growth far greater than that of domestic travel.

Foreign travel can be divided into several market segments that have different consequences for transportation:

- Travel abroad by U.S. citizens (which affects U.S. and competing carriers abroad and U.S. points of arrival and departure);
- Foreign visitor arrivals (which affect U.S. and competing carriers abroad and U.S. points of arrival and departure);
- Internal U.S. travel by foreign visitors (which affects intercity and local transportation systems, particularly with regard to information and other special needs of foreign visitors); and
- Transiting travelers (which is not historically significant in the U.S., but which could become increasingly important with the growth of land travel between Canada and Mexico, and air travel between South America and Europe via Miami and other U.S. facilities).

As with freight statistics, the measurement of these activities is linked historically with documents related to customs and immigration. The balance of payments implications of travel abroad by U.S. citizens and travel to and within the U.S. by foreign residents are other factors that have determined the nature of statistical programs treating these phenomena. Transportation statistics are in fact a by-product of these other purposes.

The primary source of information on international travel activity is the International Air Data Base, derived from form I-92 of the Immigration and Naturalization Service (INS). Form I-92 is a document that must be completed for every vessel and aircraft arriving or departing the U.S., describing the number of U.S. citizens and noncitizens carried, the port of arrival and departure, and the national registry of the carrier.

The Travel and Tourism Administration of the U.S. Department of Commerce conducts the In-Flight Survey on board aircraft departing the United States. This survey obtains information on foreign travel by U.S. citizens and travel just completed within the U.S. by foreign visitors. The survey also obtains some information regarding internal U.S. travel by visitors, including different modes of travel used while staying in the U.S. Detailed internal trip-making is not obtained.

Given the disparate set of interests in developing international travel statistics, it is not surprising that not everyone can be satisfied by the same set of information. Balance of payments calculations, immigration management, tourism, and transportation planning require somewhat different data. For instance, the I-92 system, defined by Immigration and Naturalization Service needs, makes a dis-

tinction only between citizens and aliens; it also describes the flows by port of departure and nationality of carrier. For other purposes, tourism and balance of payments, the apt distinction is based on residence rather than citizenship. Similarly, a German flying from Switzerland would be statistically indistinguishable from a Swiss national given the methods used. As in freight statistics, the present INS data identify ports of entry or departure but do not identify inland origins or destinations.

The future of these international data are in doubt, particularly in light of proposals to disband the Travel and Tourism Administration and the Department of Commerce. BTS is reviewing options to maintain these data should reorganization proposals be enacted.

Passenger Vehicles and Service Providers

HPMS and local traffic studies provide vehicle counts for automobiles, vans, and pick-ups, and data on the characteristics of trucks and vans for passenger travel are available from the TIUS; however, inventory and use data on automobiles and buses, and information on the geography of all personal-use vehicle activity, are nonexistent. We know next to nothing about the use of automobiles and other vehicles for business purposes, including the activity of taxicabs, rental cars, and company vehicle fleets. Information on buses and vans is generally limited to those used by federally funded public transit, missing an enormous number of school buses. church buses, vans used by hotels and airport shuttle services, and vehicles used by social service agencies. The federal Department of Health and Human Services subsidizes a significant quantity of transportation that is not captured in federal transportation statistics.

The quickest and most effective fix for this data gap at the national scale is expansion of the TIUS to include automobiles and buses. The distinctions between trucks, vans, automobiles, and buses has blurred into a continuum with the popularity of minivans and small pick-ups for personal use and the large but unmeasured use of automobiles for service delivery and other businesses.

While FTA's Section 15 and Section 18 programs provide some information on public providers of passenger transportation service, very little information is available on private providers or on the extensive amount of passenger transportation provided by schools, churches, and social service agencies. The first step in filling this gap would be to initiate the Charter, Rural, and Intercity Bus Survey proposed by the Bureau of the Census.

Geography of the Transportation System

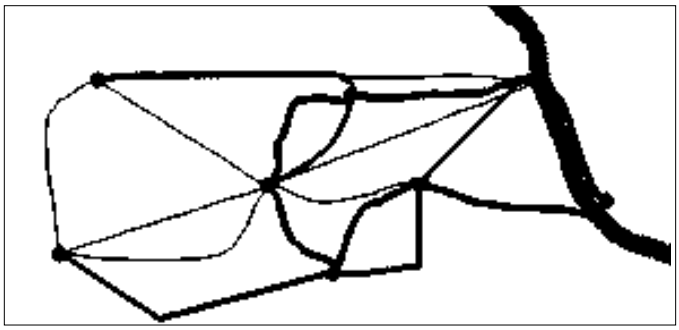
Freight and passenger transportation meet on the infrastructure. Transportation activity, services, and facilities must be combined in a geographic context to understand how well the transportation system meets its basic goals: to get people and things where they want to go, when they want to get there, at a minimum cost to the transportation user and the innocent bystander.

For the first time since 1977, DOT is developing extensive, integrated geographic data on transportation facilities and networks, the activities they serve, and the surroundings they affect. The emphasis on geographic data and analyses reflects the central purpose of transportation: to connect separate locations and accommodate the flow of people and goods. This emphasis requires refinement and application of analytical methods based on geographic information systems (GIS) technology.

BTS is organizing DOT's geographic data into four layers of information, shown in Figure 4–7. The *facilities layer* represents the location, physical characteristics, and connectivity of highways, railroads, waterways, fixed guideway transit, airports, pipelines, terminals, bridges, locks, and other structures. The *service layer* represents transportation services on and across the transportation facilities, such as bus lines and railroad trackage rights. The *flows layer* represents interactions between areas, such as commodity movements and donor/recipient financial relationships, which can be assigned to specific transportation facilities and ser-

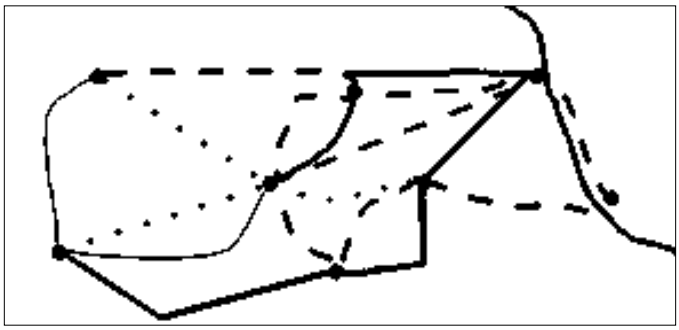
FIGURE 4–7

Layers of BTS Geographic Data

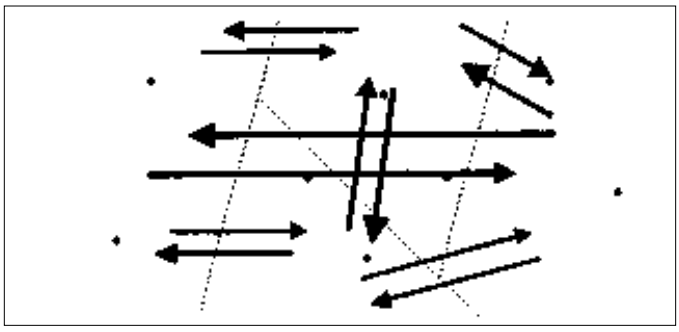


Facilities

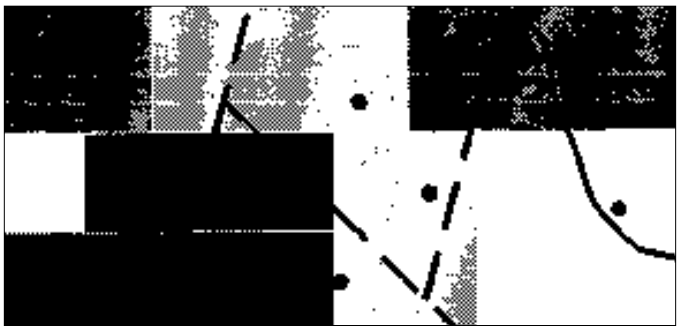
Major Transport
Balance of National
Spatial Data Infrastructure



Services



Flows



Background

Boundaries
Demographics
Econ Conditions
Environment

vices primarily with analytical models. Much of the flow data will come from the CFS, ATS, and the decennial census. Finally, the *background layer* includes data of use to the transportation community that are published and maintained by others. Examples include political boundaries, geographic names, population distributions, economic activity, and environmental conditions. Boundary and name files that help define locations for the facility, service, and flow layers will be published by BTS. BTS also plans to publish its estimates of daytime population by place, based on the 1990 Census Transportation Planning Package. The remainder of the background layer is used by BTS for creating thematic maps and preparing analyses, but is left to other agencies for dissemination.

The Bureau's efforts are parallel to a national attempt to modernize the Nation's mapping programs through interagency and intergovernmental cooperation under Executive Order 12906, *Coordination of Geographic Data Acquisition and Access: the National Spatial Data Infrastructure* (NSDI). This order assigns overall responsibility for NSDI to the Federal Geographic Data Committee (FGDC), chaired by the Secretary of the Interior. The order assigns DOT responsibility for the transportation layer of the NSDI. NSDI provides basic location (but not necessarily connectivity) data for the facilities layer through the Census Bureau's TIGER files and the Digital Line Graphs (DLGs) of the U.S. Geological Survey. NSDI is also supposed to provide a framework through which the mapping and geographic data activities of all government agencies can be brought together for efficiency, synergy, and serendipity. The need for NSDI is in part a reflection of the increasing number of government agencies involved in mapping and geographic data development, the potential analytical power of integrating electronic maps and geographic data, and the inability of federal mapping agencies to keep up with changes in the American landscape.

Table 4–2 summarizes the status of the major geographic databases for transportation. The highway network database consists of approximately 400,000 miles of highways, or 10 percent of the total roads in the United States. The rail network contains the entire mainline and secondary rail systems while the waterway network includes all navigable waters. All rail transit systems are covered.

These databases have been developed from paper maps of varying scales and associated levels of accuracy. Table 4-3 summarizes these scales and lists examples of recommended uses at each scale. As shown in the table, the 1:2,000,000 scale networks are used for national level planning and analysis functions, while the 1:100,000 scale networks are used for more localized activities at the state, regional and metropolitan level. The primary reason for this distinction is the increased size and detail required for the 1:100,000 scale networks, which directly affects the time and resources required to perform planning tasks.

The transportation databases are built on three often conflicting sources: DLGs that were originally created from maps at the 1:2,000,000 scale, DLGs that were originally created from maps at the 1:100,000 scale, and the Census TIGER/Line files that are also based on maps at the 1:100,000 scale. Differences among the sources is illustrated in Figure 4-8, which contains railroad networks from each source for central Chicago. The 1:100,000 DLGs provide the best geographic detail for older facilities, particularly with respect to shape points along network links. TIGER is more current, particularly for the street network, but often at the expense of locational precision and shape points. (Curves often show up as a straight line.) The railroad network based on the 1:2,000,000 DLGs has much less locational precision, but contains far more attribute information such as ownership and traffic carried. Differences between the 1:100,000 sources must be reconciled and information snapped from the 1:2,000,000 source to capture the best of each source.

Most transportation network data bases have been subjected to planimetric quality checks so that the maps look good, but have not been subjected to quality checks for topological accuracy. Planimetric accuracy is the traditional concern of cartographers, and topological accuracy is the concern of analysts. Planimetric accuracy means that the bridge, intersec-

TABLE 4 – 2

Major Geographic Databases for Transportation

Database	Scale of source maps	Source Agency	Status
National Highway Planning Network, version 1	1:2,000,000	FHWA/ORNL	Used for CFS; to be retired
National Highway Planning Network, version 2	1:100,000	FHWA	Initial release in 1994
Railways (to which waybill data can be attached)	1:2,000,000	FRA	Initial release in 1992
Railways	1:100,000	FRA	Initial release in 1995
Waterways	1:100,000	Interagency Consortium	Initial release in 1995
Pipelines	State-to-state network	Nat'l Petroleum Council	Used for CFS; to be retired
Pipelines	1:100,000	Office of Pipeline Safety	Planned for 1997
Fixed-guideway Transit	1:100,000	FTA	Initial release in 1995
Air Network: Freight (connectivity between airports)		BTS	Initial release in 1995
Air Network: Passenger (connectivity between airports)		BTS	Initial release in 1995
Rail Double-Stack route attribute		FRA	Initial release in 1996
Passenger / Commuter Rail route attribute		FTA	Initial release in 1995
Urban Bus Routes		FTA	Planned completion in 1996
Intercity Bus Routes		Volpe Center	Initial release in 1995
Airports		FAA / Volpe Center	Initial release in 1993
Water Ports		Corps of Engineers	Planned for 1996
Docks		Corps of Engineers	Initial release in 1995
TOFC/COFC and other Terminals		FRA	Planned for 1995
Transit Stations		FTA	Initial release in 1995
Rail-Highway Grade Crossings	1:100,000	FRA and BTS	Planned for 1996

tion, or other facility is in the right place. Topological accuracy means that bridges are distinguished from intersections, and that connections in the real world are reflected in the computer representation. Planimetric accuracy is important for visual credibility, and for linking data on transportation facilities with environmental, economic, and social information about the surrounding area. Topological accuracy is essential for most forms of transportation analysis, in which the computer must determine whether you can really get there from here.

GIS tools are generally available to edit and analyze geographic data related to transportation. Many of these tools remain complex for the user. Even if geographers and vendors begin to make GIS as easy to use a spreadsheets, additional tools are still needed. Examples of these tools include: geographic data visualization tools for multi-dimensional tabulations, chloropleth maps, and flow maps; network simplification tools for link chaining (i.e. end-on link collapsing), network spur removal (i.e. removing dead-ends), and network aggregation (i.e. merging of two or more parallel routes); and network matching tools to resolve problems such as those illustrated in Figure 4–8.

Transportation Finance

Much of the data for "information on public and private investment in intermodal transportation facilities and ser-

TABLE 4 – 3

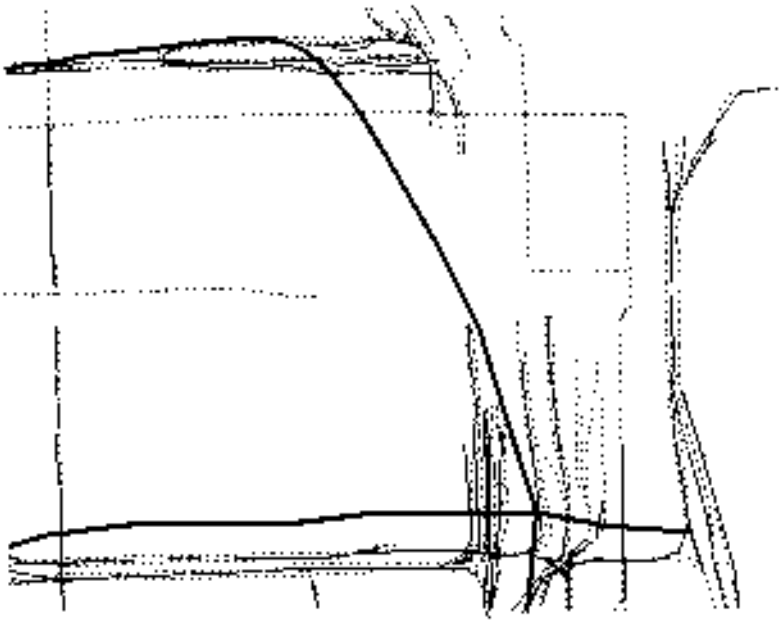
Scales of Source Material for Geographic Data

	1:2,000,000	1:1,000,000	1:100,000	1:24,000	1:10,000
Sources	USGS National Atlas, DLG's (1:2M)	Digital Chart of the World (DCW)	USGS DLG's, Census TIGER/Line	USGS Quad Maps	Property maps, engineering drawings
Root mean square positional accuracy	1,200 m (0.75 mi)		80 m (260 ft)	15 m (40 ft)	
Smallest Typical Feature Portrayed	Major highways	Major highways	City streets	Alleys	Curblines
Representative Size	51,000 links for National Highway Planning Network		110,000 links for National Highway Planning Network		
Typical Applications	National or statewide policy studies; market analyses	North American planning studies	Metropolitan travel demand studies; route planning	Route planning; IVHS applications	Facility planning, safety planning

FIGURE 4 – 8

Different Representations of Chicago's Railroads

1:2,000,000 DLG
1:100,000 TIGER
1:100,000 DLG



vices" required by title 5 of the ISTEA[5] is aspatial, or at least not the level of geographic detail as described above. This is particularly true for financial, employment, and other institution-based information that applies to a company or service, and that is typically not measured (or even possible to measure) below the county or state level.

BTS provided relatively few statistics on public finance of transportation in the first *Transportation Statistics Annual Report*; yet those statistics resulted in many favorable responses from readers who want more information.

BTS recognizes that much of the interest in public finance involves quests to uncover subsidies. Valid statistics on subsidies are very difficult to develop, especially when shared costs and indirect subsidies are included. For example, what percentage of highway patrol budgets should be considered a transportation expenditure and how much should be general public safety? The issue of subsidies within modes is at least as difficult and controversial as the issue of subsidies between modes. FHWA has made the most extensive effort to identify who is paying for what within the highway program through a series of highway cost allocation studies. A new highway cost allocation study is just getting underway, and will undoubtedly provide key information for public debates on ISTEA reauthorization.

Statistics on private finance of transportation are surprisingly limited given the extensive ownership of transportation equipment by banks and other financial institutions. Most existing financial data come through the ICC and the BTS Office of Airline Information. BTS is beginning an extensive review of its newly acquired airline statistics program to determine which data are valuable, what can be improved internally or replaced by alternatives, and what the relationships should be between the public and private sectors in the provision of the data. (See Economic Classification box.)

The Bottom Line: Performance Measurement

The study that guided the creation of BTS also called for establishment of a national transportation performance monitoring system.[6] The measures which comprise this system are the summary form of the statistics discussed throughout this chapter. These performance measures provide the basic understanding of whether transportation and the world it affects are getting better or worse; the definition of performance measures identifies what we mean by better or worse. In the intergovernmental system, where strategic transportation decisions are made by several levels of government, the relevant indicators will be specified in performance partnership.

Performance measures in transportation are typically composites of variables based on direct observation (such as traffic counts and lane miles) and variables based on estimates (such as vehicle miles of travel). For a performance measure to be effective:

- The observations underlying the variables must be accurate, reliable, and have adequate coverage.
- The estimation methods must be demonstrably unbiased.
- The composite measure must be relevant, transparent, and devoid of spurious accuracy.

Many performance measures in transportation do not pass the relevance test, either because the measure is not readily linked to the real world experience or because the measure fails to capture the desired concept. The commonly used measure of ton miles illustrates the former; very few decisionmakers can visualize a ton mile and relate it to an understood quantity. The ratio of the "transportation bill" to gross domestic product as a measure of transportation's share of the economy illustrates the latter; the numerator and the denominator are based on entirely different forms of accounting and should not be combined.

"Level of service" in highway planning is one of the more effective performance measures devised in transportation. Six levels of service are defined to represent traffic conditions from A (when vehicles can move at the posted speed and change lanes whenever you want) to F (when traffic comes to a complete standstill). The implications of each level of service for the traveler are readily understood from common experience. Level of service can be accurately established by casual observa-

Economic Classification: Industries and Commodities

The Standard Industrial Classification (SIC) system is the key to most financial and institutional data, since it provides the basic framework by which establishment-based data are collected and tabulated. The SIC affects data collection and analysis at all levels of government and in many private corporations.

As noted last year, revisions to the SIC are needed.[7] Since that time, the Economic Classification Policy Committee convened by the Office of Management and Budget has proposed a trilateral effort to replace completely the SIC with a North American Industry Classification System (NAICS).[8] NAICS is proposed to reflect changes in the economy, improve the consistency of the SIC's hierarchical structure, and improve the comparability of statistics among nations. BTS supports these goals as long as data availability and analytical integrity are not compromised. BTS is particularly concerned with the cost and philosophical basis of proposed classification system.

Cost

Any change to an economic classification system incurs costs to the programs that use that system. Forms and sample frames must be redesigned to collect data by the new classification of establishments, and statistical bridges must be built between new and old ways of tabulating the data. Some time-series data will be disrupted beyond repair. These costs must be balanced against improvements to data quality and utility before a change is accepted.

Work to date by subcommittees of the Economic Classification Policy Committee indicates that significant and numerous changes to the SIC are required to achieve comparability with the less detailed industrial classification systems in Canada and Mexico. U.S. detail would be maintained primarily by establishing a supplemental fifth digit to the proposed 4-digit NAICS codes.

The magnitude of potential changes could be costly to implement, and result in considerable loss of detail in economic data. If adopted under an international agreement, conversion to NAICS would be mandatory at a time when government budgets are declining. U.S. statistical agencies would be sorely tempted to cover conversion costs by collecting less detailed data under the reduced number of industry categories in NAICS. The supplemental fifth digit could easily become a footnote rather than a framework for data collection and tabulation.

BTS strongly recommends that the potential loss of economic data and other consequences be considered in a formal benefit-cost analysis before the U.S. agrees to adopt NAICS.

Philosophical basis

Industries can be classified by the goods and services they produce, how they produce those goods and services, or for whom they produce those goods and services. All three approaches—product based, production process based, and market based—are used with other factors in the current SIC. The Economic Classification Policy Committee proposes to use production process as the sole philosophical basis for classifying industries.

BTS believes that the production process is a very appropriate basis for classifying establishments in manufacturing, but not in other sectors of the economy. The service offered and the market served are generally more effective distinguishing characteristics of establishments outside of manufacturing. Indeed, the basic distinction between wholesale and retail trade is based on markets: whether establishments sell to businesses or households. Markets are especially important to transportation, particularly in the distinction between local and long distance carriers.

BTS recommends the use of production process for classifying establishments in manufacturing, and demand-based markets for classifying nonmanufacturing establishments. Ideally, the proposed classification can be justified by both philosophical bases. In the end, usefulness of data to a broad spectrum of analysts and decisionmakers should be more important than rigorous adherence to a single classification principle.

Commodity classification

BTS recognizes that the classification of products—including commodities and tradable services—is a valuable supplement to the classification of both manufacturing and nonmanufacturing establishments. BTS is particularly interested in a commodity classification system that:

- classifies commodities in a hierarchical structure that is relevant to transportation;
- represents commodities carried by all modes of transportation;
- is relatively easy to use by respondents to the Commodity Flow Survey;
- is compatible with the Harmonized System (HS) now used world wide; and
- can be linked to the Standard Transportation Commodity Classification (STCC) codes.

In response to problems with the use of STCC codes for the 1993 CFS, BTS has initiated research at the Volpe National Transportation Systems Center to devise a more effective classification for the 1997 survey. Should the resulting classification system prove its worth in the 1997 CFS, BTS will propose the system's adoption as a statistical standard.

tion from an aircraft or surveillance camera, and does not require detailed traffic counts or other calculations. Level of service can also be predicted by comparing traffic counts to capacity using relationships that have been established from an extensive and widely accepted empirical record.

Four sources of variables for performance measures include:

1. Observations and estimates of current conditions and recent trends for transportation planning and policy.
2. Forecasts of future conditions for transportation planning and policy, such as to determine whether the probable impacts of proposed transportation projects will conform with air quality goals.
3. Real time or daily observations to support daily transit operations, commercial vehicle dispatching, intelligent vehicle highway systems (IVHS) and other intelligent transportation systems (ITS), and other forms of transportation operations.
4. The congestion, intermodal, and other management systems mandated by the ISTEA, which in theory can link the data and analysis activities of transportation operations with those for transportation planning and policy.

DOT has undertaken a departmentwide effort in 1995 to identify key performance measures as part of Secretary Peña's National Transportation System initiative. BTS is participating in this effort to assure that the Bureau's statistics are policy relevant as well as policy neutral.

BTS views the development of performance measures as an evolutionary process, documented each year by the contents of the *Transportation Statistics Annual Report* and its companion volume, *National Transportation Statistics*. The Bureau's success in developing effective performance measures will depend in large part on continuing feedback from users of both volumes. BTS encourages that feedback through the many communication channels identified at the beginning of this report.

Endnotes

1. 49 USC 111 (f).
2. Independent owner-operators who do not have payrolls and trucking provided by the shipper for its own account are the missing pieces.
3. DOT has proposed transfer of ICC reporting authority to the Department if sunset legislation is passed.
4. Screen lines are locations which divide a region for purposes of measuring intraregional activity.
5. 105 Stat. 2158.
6. Transportation Research Board, *Data for Decisions*, Special Report 234, National Research Council, Washington, D.C., 1992.
7. *Transportation Statistics Annual Report*, 1994, pp. 194–198.
8. *Federal Register*, July 26, 1994, pp. 38092–38096.